Site and landscape features ruling the habitat use and occupancy of the polecat (*Mustela putorius*) in a low density area: a multiscale approach

J. Zabala * I. Zuberogoitia * J. A. Martínez-Climent

J. Zabala (corresponding author)
Sebero Otxoa 45 5 B. 48480 Arrigorriaga. Bizkaia. Basque Country, Spain, and
Zoologia lab., Zoologia eta A.Z.D. saila E.H.U.-U.P.V. P.O. BOX 644, E-48080 Bilbao, Bizkaia, Basque Country, Spain
E-Email: jzabalaalbizua@yahoo.com

I. Zuberogoitia
Zoologia lab., Zoologia eta A.Z.D. saila E.H.U.-U.P.V. P.O. BOX 644, E-48080 Bilbao, Bizkaia, Basque Country (Spain)

J. A. Martínez-Climent
C/ Juan de la Cierva 43, E-03080 El Campello, Alicante, Spain

European Journal of Wildlife Research 51 (3): 157-162.
The original publication is available at www.springerlink.com
DOI 10.1007/s10344-005-0094-z

Abstract

We studied the habitat of the polecat at different scales in a low density area. For this purpose we gathered data on the presence of the species and characterised them by location, home range and landscape scales. Polecats selected areas of high diversity close to, but not in, streams whilst avoided intensively managed conifer plantations and dense urban areas. Variables determining the presence/absence of the species were found at home range scales, what implies that management and conservation practices for the species should be aimed mainly at this scale. Finally, our results agree with previously published works, what validates GIS based approaches as a tool for carnivore management in areas with scarce data or in cases of rare species.

Keywords: Polecat, Conservation, Management, Landscape, GIS modelling.

Introduction

Polecat (*Mustela putorius*) is a widespread carnivore in Europe whose populational trends are poorly understood. Whilst their distribution area has expanded northwards, in some areas polecats have undergone a decline in the last decades (Blandford 1987; Brzezinski et al. 1992; Birks and Kitchener 1999). They use a great variety of vegetation types and structures and some studies have pointed out its preference for watercourses (Blandford 1987; Brzezinski et al. 1992; Jedrzejewski et al. 1993; Sidorovich et al. 1996). However, other studies showed selection for other vegetation formations such as prairies, forests or human settlements and nearby areas (Blandford 1987; Lodé 1993; Virgós 2003). But, with some exceptions (Lodé 1993, 1994, 1995), habitat requirements of the species are poorly known, especially in low density areas (Virgós 2003). Therefore, management guidelines for low density areas are usually extrapolated from high density areas or from similar species.

Habitat selection and use are the result of several processes that take place at different scales. Johnson (1980) defined four levels of habitat selection. But, for carnivores, some scales of habitat selection have been scarcely considered (Carroll et al. 1999; Gough and Rushton 2000; Schadt et al. 2002).

Cryptic, nocturnal and rare species usually require indirect approaches for studying their habitat requirements, especially when they occur at low densities. In such cases, indirect methods have been widely used (Gese 2001; Wilson and Delahay 2001; Virgós 2003). However, each technique deals with different methodological and logistic drawbacks, and in every case the rarity of the species could yield scarce data for analysis (Gese 2001; Kenward 2001).

In this work we merged data from different sources and modellized them to obtain an approximation of the habitat of the polecat at three different scales: use of features within the home range, location of home range with respect to surrounding area and use at the landscape level. Secondly, we developed a GIS with all the relevant habitat features for the species which occurs at very low densities in the area, and contrasted the results with published works on polecat's biology in order to assess the reliability of the proposed procedure. Thus we aim to provide a rational, efficient tool so as to develop more efficient monitoring plans in a changing landscape.

The original publication is available at www.springerlink.com
DOI 10.1007/s10344-005-0094-z

Materials and Methods

Study area

The study was conducted in Biscay, Basque Country (SW Europe). Biscay, is 2236 km² with a population about 1.2 million inhabitants. Landscape is hilly and rugged, and altitudes range from 0 to 1475m a. s. l. (Gorbea Peak) Climate is oceanic, with annual rainfall ranging between 1200 and 2200 mm, and annual average temperatures varying from 13.8ºC to 12ºC. Winters are mild and there is no summer drought. The region has several catchments whose streams are short, small and fast flowing, running into the Bay of Biscay. Main infrastructures such as roads and villages are located along valleys. In the mountains and valleys far from urban areas, land is mainly devoted to forest cultures, mainly exotic *Pinus radiata* and *Eucalyptus globulus* that occupy more than half the surface of Biscay (Department of Environment and Land Ordination 2001).

Methods

Firstly we gathered all data available on polecats dating back up to eight years from wildlife keepers, scientists, naturalists and the regional wildlife rescue centre. We only considered reliable data such as trapping data (5 animals with a trapping effort over 6000 traps/night), road kills (7 animals) and torching and sightings (10 animals). In the latter cases, records were disregarded when carcasses were not available for identification or the sighting had not been reported by us. In total we gathered 22 records of polecat presence. Based on these records we built polygons representing polecat distribution in the study area. Besides, we set a buffer around the area to avoid the misrepresentation of presence areas of outlier data outside the polygon. For the buffer we used a distance of three kilometres, based on the linear dimension of the home range (Bowman et al. 2002) obtained from a radio tracked polecat in the study area. The size of this home range was similar to those previously reported in the literature (Brzezinski et al. 1992; Blanford 1987; Lodé 1996a).

The analysis was performed at three different scales: (1) use of features within home range, (2) home range site location and (3) the importance of landscape correlates with presence of polecats. Vegetation cover and distance calculations were made through a GIS using digital cartography at 1:5000 and 1:25000 scales, provided by the Department of Environment and Land Ordination of the Basque Government. To ensure

European Journal of Wildlife Research 51 (3): 157-162.
The original publication is available at www.springerlink.com
DOI 10.1007/s10344-005-0094-z

the availability of sites from which polecats are absent, so as to provide a better approximation (Jones 2001), we modelled the polecat's dispersion area by setting buffers of six km around the built polecat distribution area and considered that surface as available for the species (Bowman et al. 2002), and created 31 random points in the area.

For the first analysis we created buffers with a radius of 10 metres around known polecat locations and considered the habitat composition in these areas using a 5 metres grid, and measured distances from them to the nearest river and to the nearest ecotone. We also generated 23 random points within the potential polecat distribution area and characterised them in the same way.

In the second analysis we made an approximation of the home range area location. To ensure representativeness of areas considered as home ranges we first calculated the area that can be considered as part of the home range with statistical significance. For doing so we considered a home range area of 2.5 km² based on own data from a radio-tagged polecat and data reported in literature (Brzezinski et al. 1992; Blanford 1987; Zuberogoitia et al. 2001). Taking into account the home range size of polecats, we created a circle with an area of 2.5 km² and, assuming a regular distribution of the locations within the home range, created 20 normal random points inside the circle. Then we calculated the distance from each point to the circle border, listed a series of distances and compared them to the actual distances included in home ranges. Wilcoxon's paired samples test (Zar 1999) were performed to find for which distance pairs there were no statistically significant differences between distances considered and those actually included in the home range. The maximum distance to consider was 100 metres (for 50 metres: Wilconxon's $z=-1.604$, $p<0.109$; 100 metres: $z=-1.826$, $p<0.068$; 150 metres: $z=-2.366$, $p<0.018$). Thus, we created circles with a 100 metres radius around polecat locations and considered the resulting circular areas as part of the home ranges of the animals.

Vegetation cover of positive and negative areas was described r using a GIS to create a vegetation grid (5 m resolution). Besides we also considered the number of polygons included in the area and the length of streams and ecotones inside the area (Table 1).

Finally, for landscape analysis we considered, as a rule of thumb, a radius of 2 km, giving circular areas of 12.5 km². To avoid spatial biases and pseudo-replication

European Journal of Wildlife Research 51 (3): 157-162.
The original publication is available at www.springerlink.com
DOI 10.1007/s10344-005-0094-z

only one point was considered in overlapping areas, and negative points with buffers considerably overlapping the distribution area were not considered. In consequence only 14 presence points and 19 absence points were used.

The data was analyzed using different statistical tests. In the first case we performed χ^2 analysis with Bonferroni's inequality (Manly et al. 1993; Morrison et al. 1998). In addition, electivity for the different habitat categories was assessed through Jacob's index (Krebs 1989). Differences in the distance to the nearest river and ecotone were tested with the Mann-Whitnes U test. Mann-Whitnes U tests were also performed at home range order and landscape use order (Table 1). Finally, in order to determine which variables ruled habitat use at the home range and landscape scales we performed a Logistic Regression (LR) with the variables using the forward Wald Stepwise method and the binary response variable presence/absence of polecat as dependent variable (Morrison et al. 1998).

Finally we performed a LR considering only the variables that reached statistical significance in previous tests at any of the three orders of habitat use considered; in order to determine which selection order ruled the overall habitat use of the polecat and was responsible for the presence/absence of the species in an integrated context.

Results

Use of areas within the home range

Polecat locations showed statistically significant avoidance of pine forests, using all the other habitat categories according to their availability. However, there was a marked tendency of preference for human settlements, which reached statistical significance at the 92.5%-level. Besides, polecat locations were significantly nearer than randomly selected points to both, rivers and ecotones ($Z=-2.983$, $p=0.003$ and $Z=-2.387$, $p=0.017$ respectively).

Selection of home range location in comparison to surrounding habitat

Only differences in the length of the rivers included in the area reached statistical significance, with more rivers in the presence polygons (Table 2). The LR selected the same feature (Table 3).

Landscape use

European Journal of Wildlife Research 51 (3): 157-162.
The original publication is available at www.springerlink.com
DOI 10.1007/s10344-005-0094-z

Polecats selected landscapes significantly more diverse and with less presence of urban areas (Table 4). The LR for this order pointed out presence of urban areas as the variable ruling the habitat use (Table 3). Indeed, there was a statistically significant negative correlation between the proportion of urban habitat in the area and mosaicisim expressed as number of different habitat polygons (Pearson's correlation's coefficient, $r = -0.710$, $P < 0.001$, $n=33$).

Finally, the LR including variables significant at all the three orders highlighted the length of rivers included in the 100 metres radius as the most determinant of all for the presence of European polecats (table 3).

Discussion

Habitat use of the polecat has been explained by seasonal variations in trophic resources, mainly small mammals and amphibians (Blandford 1987; Weber 1989; Brzezinski et al. 1992; Jedrzejewski et al. 1993; Lodé 1993, 1994, 1995, 1996b, 1997, De Marinis and Agnelli 1996; Sidorovich et al. 1996; Zuberogoitia et al. 2001; Baghli et al. 2002). Moreover, the polecat is known to intensively exploit areas where resources are locally abundant (Lodé 1994, 1995). Our results agree with this pattern of selection by polecats of a high degree of structural diversity near to streams and ecotones, where amphibians and small rodents are abundant (Escala et al. 1997; Marnell 1998; Houlahan and Findlay 2003). In Biscay, areas surrounding streams are typically most diverse and productive. Moreover, meadows and areas close to streams are usually damp as a consequence of the rainy climate and may function as amphibians spawning and gathering sites, while human rural settlements in such areas improve their productivity. Polecats avoided conifer forests, which apparently contradicts the results of some works that pointed out the use of forest by polecats (Lodé 1994; Weber 1989) and relationships between the presence of native pine forest in the landscape and polecats (Virgós 2003). However, in the study area pine forests are intensively managed timber monospecific plantations of poor floristic and faunal diversity. Moreover, intensive forest management has reduced amphibian diversity and abundance, whilst lack of floristic diversity affects rodents and other small mammals (Waldick et al. 1999; Zuberogoitia 2002; Holulahan and Findlay 2003; Chan-Mcleod 2003). Conifer forests are most commonly in abandoned rural areas, usually in the poorest agricultural lands and in steep lands.

European Journal of Wildlife Research 51 (3): 157-162.
The original publication is available at www.springerlink.com
DOI 10.1007/s10344-005-0094-z

The different use of human settlements (i. e., urban areas) emerging at different scales was very interesting. On the one hand, the observed tendency of the polecat towards urban areas might be the consequence of two factors: a bias towards humanised areas created by the nature of data (road kills, capture of problematic individuals damaging poultry), and the selection of small rural villages and human settlements often reported in literature (Blandford 1987; Weber 1989; Brzezinski et al. 1992). On the other hand, polecats were absent from highly urbanised areas at a landscape scale. Urban areas avoided by polecats were cities, industrial areas and big concentrations of country residential areas, as opposed to traditional farm exploitations found in the first level. Such areas create a great human pressure over wildlife and a simplification and fragmentation of the landscape, which is no longer devoted to agricultural production. Besides, polecats occupied patchy landscapes also at the landscape scale Two important factors may explain this result. Firstly by including diversity of habitats polecats would enhance food resources allowing them to cope with temporal scarcity or seasonal shifting on habitat-specifity of prey resources. Secondly, landscape and vegetation cover diversity may enhance connectivity in the landscape matrix.

It is remarkable, however, that in spite of the use for areas close to rivers only a single datum was located in riverbank. This can be explained by the rugged landscape of the area, with rural areas and productive lands clustered in the valley-bottoms. In the study area several frog and toad species cluster for reproduction on boggy meadows and forest bogs rather than in fast flowing and usually polluted streams (Bea 1989). Indeed, on several occasions we have found typical polecat feeding signs, common frog heads and skins, in forest bogs. The tagged polecat had an areal home range rather than a linear one, and never used streams (Zuberogoitia et al. 2001). This implies that although in experiments conducted in captivity polecats showed an aggressive behaviour towards European minks (Schröpfer et al. 2001) there seems to be a strong component of spatial segregation between species in the wild thus reducing the likelihood of aggressive encounters (see Lodé 1993; Sidorovich et al. 1996; Sidorovich et al. 2000).

The LR model including features selected at any habitat use order singled out the length of rivers in the 100-m radius as the variable determinant for the presence of the polecat. Predators view and respond to habitat fragmentation and modification at different scales depending on their vagility, with less mobile or more stenophagous predators responding to habitat modification at smaller scales (Gehring and Swihart

European Journal of Wildlife Research 51 (3): 157-162.
The original publication is available at www.springerlink.com
DOI 10.1007/s10344-005-0094-z

2003). Polecats have a relatively small body size for carnivores and usually exhibit home ranges of around 1.5 km² (Blanford 1987; Weber 1989; Lodé et al. 2003; but see Brzezinski et al. 1992 for nomadic behaviour). Therefore, we could expect polecats to respond to landscape modifications and to have a low response threshold to fragmentation (i. e. responses at smaller scales) as shown by our results. This result has several conservation and management implications. For instance, it can be suggested that the survival of the species depends heavily on changes made at local scales rather than at wider geographical ranges. It can also be suggested that abandonment or modification of local traditional agricultural practices or the creation of barriers could eventually eradicate polecats. Moreover, if we consider that polecat populations are composed of scattered breeding units with intrasexually exclusive territories (Lodé 1996a; 2001; 2003; Lodé et al. 2003), modifications at local scales might isolate breeding units making populations more susceptible to local extinctions (the allee effect; Frank and Woodroffe 2001; Lodé et al. 2003).

Finally, regarding methodology, our multiscale approach is concordant with previous works in revealing the relative importance of different habitat features at biologically meaningful spatial scales (Martinez et al. 2003). The approach at different scales provides further insight in wildlife-landscape relationships and a best understanding of the way in which different order of habitat selection and use interact, thus becoming a powerful technique for management and conservation.

Acknowledgements

The authors wish to express their gratitude to the Department of Environment and Land Ordination of the Basque Government for providing digital cartography, to the Bizkaia Wildlife Rescue Centre and regional wildlife keepers for providing information on trapped animals and road kill, and to E. Virgós, Prof. T. Lodé and one anonymous reviewer for useful comments on previous drafts.

References

Baghli A, Engel E, Verhagen R (2002) Feeding habits and trophic niche overlap of two sympatric Mustelidae, the polecat *Mustela putorius* and the beech marten *Martes foina*. Z Jagdwiss 48:217-225

Birks J, Kitchener AC (1999) The distribution and status of the polecat (*Mustela putorius*) in Britain in the 1990's. Vincent Wildlife Trust, Herefordshire

Blandford PRS (1987) Biology of the polecat *Mustela putorius*: a literature review. Mammal Rev 17:155-198

Bowman J, Jaeger JAG, Fahrig L (2002) Dispersal distance of mammals is proportional to home range size. Ecology 83:2049-2055

Brzezinski M, Jedrzejewski W, Jedrzejewska B (1992) Winter home ranges and movements of polecats *Mustela putorius* in Bialowieza primeval forest, Poland. Acta Theriol 37:181-191

Carroll C, Zielinski WJ, Noss RF (1999) Using presence-absence data to build and test spatial habitat models for the fisher in the Klamath region, U.S.A. Conserv Biol 13:1344-1359

Chan-McLeod ACA (2003) Factors affecting the permeability of clearcuts to red-legged frogs. J Wildl Manage 67:663-671

De Marinis AM, Agnelli P (1996) First data on the winter diet of the polecat *Mustela putorius* (Carnivora, Mustelidae) in Italy. Mammalia 60:144-146

Department of Environment and Land Ordination (2001) Medio Ambiente en la Comunidad Autónoma del País Vasco. Basque Government, Vitoria-Gasteiz

Escala MC, Irurzun JC, Rueda A, Ariño AH (1997) Atlas de los insectívoros y Roedores de Navarra. Análisis biogeográfico. Publicaciones de biología de la Universidad de Navarra, Servicio de Publicaciones de la Universidad de Navarra, Pamplona

Frank LG, Woodroffe R (2001) Behaviour of carnivores in exploited and controlled populations. In: Gittleman JL, Funk SM, Macdonald DW, Wayne RK (Eds) Carnivore Conservation. Cambridge University Press, Cambridge: pp. 419-442

Gehring TM, Swihart RK (2003) Body size, niche breadth, and ecologically scaled responses to habitat fragmentation: mammalian predators in an agricultural landscape. Biol Conserv 109:283-295

Gese EM (2001) Monitoring of terrestrial carnivore populations. In: Gittleman JL, Funk SM, Macdonald DW, Wayne RK (Eds) Carnivore Conservation. Cambridge University Press, Cambridge: pp. 372-396

Gough MC, Rushton SP (2000) The use of GIS in modelling the landscape ecology of mustelids. Mammal Rev 30:197-217

Houlahan JE, Findlay CS (2003) The effects of adjacent land use on wetland amphibian species richness and community composition. Can J Fish Acqua Sci 60:1078-1094

Jedrzejewski W, Jedrzejewska B, Brzezinski M (1993) Winter habitat selection and feeding habits of polecats (*Mustela putorius*) in the Bialowieza National Park, Poland. Z Säugetierk 58:75-83

Johnson DH (1980) The comparison of usage and availability measurements for evaluating resource preference. Ecology 61:65-71

Jones J (2001) Habitat selection studies in avian ecology: A critical review. The Auk 118:557-562

Kenward R (2001) A manual for wildlife radio tagging. Academic press, London

Krebs CJ (1989) Ecological Methodology. HarperCollins, New York

Lodé T (1993) Diet composition and habitat use of sympatric polecat and American mink in western France. Acta Theriol 38:161-166

Lodé T (1994) Environmental factors influencing habitat exploitation by the polecat *Mustela putorius* in western France. J Zool, Lond 234:75-88

Lodé T (1995) Activity pattern of polecats *Mustela putorius* L. in relation to food habits and prey activity. Ethology 100:295-308

Lodé T (1996a) Conspecific tolerance and sexual segregation in the use of space and habitats in the European polecat. Acta Theriol 41:171-176

Lodé T (1996b) Polecat predation on frogs and toads at breeding sites in western France. Ethol Ecol Evol 8:115-124

Lodé T (1997) Trophic status and feeding habits of the European polecat *Mustela putorius* L. 1758. Mammal Rev 27:177-184

Lodé T (1999) Time budget as related to feeding tactics of European polecat *Mustela putorius*. Behav Proc 47:11-18

Lodé T (2001) Mating system and genetic variance in a polygynous mustelid, the European polecat. Genes Genet Syst 76:221-227

Lodé T (2003) Sexual dimorphism and trophic constraints: Prey selection in the European polecat (*Mustela putorius*). Ecoscience 10:17-23

Lodé T, Pereboom V, Berzins R (2003) Implications of an individualistic lifestyle for species conservation: lessons from jealous beasts. C R Biologies 326:S30-S36

Manly F J, McDonald L, Thomas D L (1993) Resource selection by animals. Chapman & Hall, London

The original publication is available at www.springerlink.com
DOI 10.1007/s10344-005-0094-z

Marnell F (1998) Discriminant analysis of the terrestrial and aquatic habitat determinants of the smooth newt (*Triturus vulgaris*) and the common frog (*Rana temporaria*) in Ireland. J Zool, Lond 244:1-5

Martínez J A, Serrano D, Zuberogoitia I (2003) Predictive model of habitat preferences for the Eurasian Eagle owl *Bubo bubo*: a multiscale approach. Ecography 26:21-28

Morrison ML, Marcot BG, Mannan RW (1998) Wildlife-habitat relationships; Concepts and applications. The University of Wisconsin Press, Wisconsin

Schadt S, Revilla E, Wiegand T, Knauers F, Kaczensky P, Breitenmoser U, Bufka L, Červený J, Koubek P, Huber T, Staniša C, Trepl L (2002) Assessing the suitability of central European landscapes for the reintroduction of Eurasian lynx. J Appl Ecol 39:189-203

Schröpfer R, Bodenstein C, Seebass C, Recker K, Jordan M (2001) Niche analysis of the *Mustela* species *lutreola*, *putorius* and *vison* by craniometry and behavioural observations. Säugetierk Inf 25:121-132

Sidorovich V, Jedrzejewska B, Jedrzejewski W (1996) Winter distribution and abundance of mustelids and beavers in the river of Bialowieza Primeval Forest. Acta Theriol 41:155-170.

Sidorovich VE, Macdonald DW, Kruuk H, Krasko DA (2000) Behavioural interactions between the naturalized American mink *Mustela vison* and the native riparian mustelids, NE Belarus, with implications for population changes. Small Carnivore Conserv 22:1-5

Virgos E (2003) Association of the polecat *Mustela putorius* in eastern Spain with montane pine forests. Oryx 37:484-487

Waldick RC, Freedman B, Wassersug RJ (1999) The consequences for amphibians of the conversion of natural, mixed-species forests to conifer plantations in southern New Brunswick. Can Field Nat 113:408-418

Weber D (1989) The ecological significance of resting sites and the seasonal habitat change in polecats (*Mustela putorius*). J Zool, Lond 217:629-638

Wilson GJ, Delahay RJ (2001) A review of methods to estimate the abundance of terrestrial carnivores using signs and field observations. Wildlife Res 28:151-164

Zar J H (1999) Biostatistical analysis. Prentice Hall, Upper Saddle River

Zuberogoitia I (2002) Ecoetología de las rapaces nocturnas en Bizkaia. PhD Thesis, UPV-EHU, Leioa

Zuberogoitia I, Torres JJ, Zabala J, Campos MA (2001) Carnívoros de Bizkaia. BBK, Bilbao

European Journal of Wildlife Research 51 (3): 157-162.
The original publication is available at www.springerlink.com
DOI 10.1007/s10344-005-0094-z

Table 1: Variables considered at each scale for habitat description. Radius states for the distance considered around the exact polecat location (in metres).

Variables considered for		Habitat						River	Mosaicism
Analysis order	radius								
Selection within home range	10	Main habitat in the area						Distance to nearest river	Distance to nearest ecotone
Home range site selection	100	Conifer Forests	Broad leaf forests	Meadows	Urban (Human Settlem.)	Bush Land	Others	Length of rivers included in the area	Polygon border length in the area
Landscape	2000	Conifer Forests	Broad leaf forests	Meadows	Urban (Cities)	Bush Land	Others	Length of rivers included in the area	Numbers of polygons in the area

The original publication is available at www.springerlink.com
DOI 10.1007/s10344-005-0094-z

Table 2. Results of the home range analysis (Mann-Whitney U test). Mean values express the proportion of home range occupied by each habitat type. River stands for river length within the home range (in metres), and polygons for the amount of habitat polygons in the home range (numbers). Standard deviation is given in brackets.

Variable	Mean Value		U value	Z value	Signif. (2-tailed)
	Presence	Absence			
Conifer forests	17.4 (31.6)	23.7 (32.8)	293.0	-0.969	0.333
Broad leaf forests	22.2 (35.6)	11.7 (26.3)	309.0	-0.663	0.507
Meadows	25.1 (35.9)	25.8 (38.1)	300.5	-0.729	0.429
Urban	16.0 (25.7)	22.2 (37.4)	335.0	-0.128	0.898
Bush land	11.6 (20.8)	12.8 (24.2)	328.0	-0.289	0.773
Others	7.6 (13.4)	3.8 (13.0)	278.0	-1.604	0.109
River	180 (195)	46 (86)	180.5	-3.202	0.001
Ecotones	261 (182)	185 (146)	257.0	-1.523	0.128

The original publication is available at www.springerlink.com
DOI 10.1007/s10344-005-0094-z

Table 3: Results of the LR and predictive value of the model at different scales.

Scale	Variable	Wald	Degrees of Freedom	p	Correctly predicts		
					Presence	Absence	Total
Home range	River length in area	8.798	1	0.003	80.6%	59.1%	71.7%
Landscape	Urban area	4.581	1	0.032	73.7%	78.6%	75.8%
All orders	River length in 100 m. area	4.828	1	0.028	72.7%	68.2%	69.7%

European Journal of Wildlife Research 51 (3): 157-162.
The original publication is available at www.springerlink.com
DOI 10.1007/s10344-005-0094-z

Table 4. Results of landscape selection analysis using Mann-Whitney U test. Data are given in proportion of polygon occupied by different structures, river in kilometres and polygon in numbers. Standard deviation is given in brackets.

Variable	Mean Value		U value	Z value	Signif. (2-tailed)
	Presence	Absence			
Conifer forests	34.32 (16.85)	24.96 (19.72)	94.0	-1.457	0.152
Broad leaf forests	20.60 (13.24)	14.28 (10.55)	94.0	-1.421	0.163
Meadows	26.20 (14.76)	26.71 (12.83)	125.0	-0.291	0.788
Urban	4.04 (7.49)	18.70 (20.04)	32.00	-3.679	0.000
Bush land	14.85 (11.90)	15.34 (20.04)	123.0	-0.364	0.733
Others	7.6 (13.3)	3.8 (13.0)	278.0	-1.604	0.109
River	7.23 (3.32)	9.09 (5.59)	113.0	-0.729	0.483
Polygons	250.91 (77.23)	189.79 (66.90)	73.5	-2.168	0.029

European Journal of Wildlife Research 51 (3): 157-162.
The original publication is available at www.springerlink.com
DOI 10.1007/s10344-005-0094-z